A

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.:	D/99844 690-009315-US (PAR)	Total Pages:	3
First Named Inventor or Application Identifier			
Edward B. Caruthers			
Express Mail Label No.:			

APPLICATION ELEMENTS

See MPEP Chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. ☒ Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)

2. ☒ Specification (incl. claims) (Total Pages: 20)

3. ☒ Drawing(s) (35 USC 113) (Total Sheets: 3)
☐ Informal ☐ Formal

4. ☒ Oath or Declaration (Total Pages: 2)
a. ☒ Newly executed (original or copy) ☐ Unexecuted
b. ☐ Copy from a prior application (37 CFR 1.63(d)) (for continuation/divisional with Box 17 completed) [Note Box 5 below]
☐ i. DELETION OF INVENTOR(S)
Signed statement attached deleting Inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

5. ☐ Incorporation By Reference (usable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. ☐ Microfiche Computer Program (Appendix)

7. Nucleotide and/or Amino Acid Sequence Submission (If applicable, all necessary)
a. ☐ Computer Readable Copy
b. ☐ Paper Copy (Identical to computer copy)
c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. ☒ Assignment Papers (cover sheet & document(s))

9. ☐ 37 CFR 3.73(b) Statement (when there is an assignee) ☐ Power of Attorney

10. ☐ English Translation Document (if applicable)

11. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations

12. ☐ Preliminary Amendment

13. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)

14. ☐ Small Entity Statement(s) ☐ Statement filed in prior application, Status still proper and desired

15. ☐ Certified Copy of Priority Document(s)
(If foreign priority is claimed)

16. ☐ Other:

17. ☐ If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:
☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No:

18. CORRESPONDENCE ADDRESS
☐ Same as prior application ☒ Correspondence address below

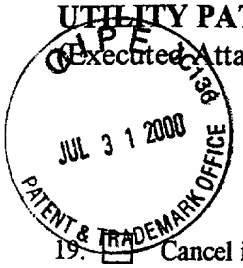
NAME Perman & Green, LLP

ADDRESS Perman & Green, 425 Post Road

CITY Fairfield STATE CT ZIP CODE 06430

COUNTRY U.S.A. TELEPHONE 203-259-1800 FAX 203-255-5710

The PTO did not receive the following listed item(s) Return Receipt Postcard



Attorney Docket No. 690-009315-US (PAR)

19. ☐ Cancel in this application original claims: of the prior application before calculating the filing fee. (At least one original independent claim is retained for this filing).

20. ☒ The filing fee is calculated below:

CLAIMS AS FILED, LESS ANY CLAIMS CANCELED BY ABOVE-INDICATED AMENDMENT(S)				
(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
TOTAL CLAIMS (37 CFR 1.16(c))	**23** - 20 =	**3**	x $ 18	= **$54.00**
INDEPENDENT CLAIMS (37 CFR 1.16(b))	**4** - 3 =	**1**	x $ 78	= **$78.00**
MULTIPLE DEPENDENT CLAIMS (IF APPLICABLE) (37 CFR 1.16(d))		ANY - - **0**	$ 260	= **$ 0.00**
		BASIC FEE (37 CFR 1.16(a))		$690.00
		TOTAL	=	$822.00

21. ☒ The Commissioner is hereby authorized to charge any filing or prosecution fees which may be required, under 37 CFR 1.16, 1.17, and 1.21 (but not 1.18), or to credit any overpayment, to Account No. 24-0037. An additional copy of this form is enclosed.

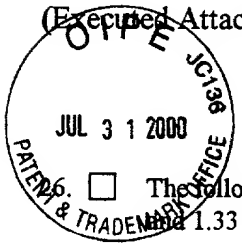
22. ☒ This is an authorization under 37 CFR 1.136(a)(3) to treat any concurrent or future reply, requiring a petition for extension of time, as incorporating a petition for the appropriate extension of time.

23. ☐ Amend the specification by inserting before the first line the sentence:
--This application is a ☐ continuation ☐ continuation-in-part ☐ divisional of Application(s) No(s). , filed .--

24. ☐ A CIP declaration is enclosed.

25. ☒ Power of Attorney

a. ☐ The power of attorney appears in the original papers of the enclosed prior application.
b. ☐ Enclosed is a copy of the declaration and power of attorney from the enclosed prior application.
c. ☒ A new declaration with power of attorney is enclosed.



Attorney Docket No.: **690-009315-US (PAR)**

26. ☐ The following inventors named in the prior application are deleted per 37 CFR 1.53(b)(1), 1.63(d)(2) and 1.33 (b):

27. ☐ This application is adding one or more inventors under 37 CFR 1.48 to a previously executed application, with an enclosed: petition, fee, newly executed declaration from all inventors, and written consent of the assignee.

28. ☐ This application claims the priority benefit of one or more Provisional Application No(s). and the first sentence of this application has been or will be amended to so indicate.

29. ☐ Priority is claimed from
(reinsert all previous priority claims for the entire chain of any prior applications).

30. ☐ Other paper(s) enclosed:

Respectfully submitted,

Clarence A. Green
Signature per 37 CFR 1.33 & 34
Date:
Registration No. 24,622
Telephone No. 203/259-1800

690-009315-US(PAR)

Patent Application Papers Of: Edward B. Caruthers

For: A Method and System for Adjusting Color Mixing Due to Substrate Characteristics

A Method and System for Adjusting Color Mixing Due to Substrate Characteristics

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to document processing machines and, more particularly, to document processing machines adapted to color printing.

2. Prior Art

Referring to Fig. 1, there is shown a perspective view of a document processing apparatus 5. The apparatus 5 could be any suitable type of document processing apparatus, such as a copier, a facsimile machine, a scanner, or a computer printer adaptable to color processing and printing on a printable substrate.

One specific application of color processing is customer selectable color printing, wherein a very specific color is required. Customer selectable colors are typically utilized to provide instant identification and authenticity to a document. As such, the customer is usually concerned that the color meets particular color specifications. For example, the red color associated with the XEROX™ digital stylized "X" is a customer selectable color having a particular shade, hue and color value. Likewise, the particular shade of orange associated with Syracuse University is a good example of a customer selectable color. A more specialized example of customer selectable color output can be found in the field of custom color, which specifically refers to registered proprietary colors, such as used, for example,

in corporate logos, authorized letterhead and official seals. The yellow associated with KODAK™ brand products, and the brown associated with HERSHEY™ brand products are good examples of exacting custom colors which may be required in a highlight color or spot color printing application. However, the various colors typically utilized for standard highlighting processes generally do not precisely match customer selectable colors. Moreover, customer selectable colors typically cannot be accurately generated via halftone process color methods because the production of solid image areas of a particular color using halftone image processing techniques typically yields non-uniformity of the color in the image area. Further, lines and text produced by halftone process color are very sensitive to mis-registration of the multiple color images such that blurring, color variances, and other image quality defects may result.

As a result of the deficiencies noted above, customer selectable color production in electrostatographic printing systems is typically carried out by providing a singular premixed developing material composition (e.g., ink) made up of a mixture of multiple color toner particles blended in preselected concentrations for producing the desired customer selectable color output. This method of mixing multiple color toners to produce a particular color developing material is analogous to processes used to produce customer selectable color paints and inks. In offset printing, for example, a customer selectable color output image is produced by printing a solid image pattern with a premixed customer selectable color printing ink as opposed to printing a plurality of halftone image patterns with various primary

colors or compliments thereof. This concept has generally been extended to electrostatographic printing technology, as disclosed, for example, in commonly assigned U.S. Pat. No. 5,557,393, wherein an electrostatic latent image is developed by a dry powder developing material comprising two or more compatible toner compositions to produce a customer selectable color output.

Customer selectable color printing materials including paints, printing inks and developing materials can be manufactured by determining precise amounts of constituent basic color components making up a given customer selectable color material, providing precisely measured amounts of each constituent basic color component and thoroughly mixing these color components. This process is commonly facilitated by reference to a color guide or swatch book containing hundreds or even thousands of swatches illustrating different colors, wherein each color swatch is associated with a specific formulation of colorants. Probably the most popular of these color guides is published by Pantone®, Inc. of Moonachie, N.J. The Pantone® Color Formula Guide expresses colors using a certified matching system and provides the precise formulation necessary to produce a specific customer selectable color by physically intermixing predetermined concentrations of up to four colors from a set of up to 16 principal or basic colors.

There are many colors available using the Pantone® system or other color formula guides of this nature that cannot be produced via typical half tone process color methods. In the typical operational environment, an electrostatographic printing system may be used to print

various customer selectable color documents. To that end, replaceable containers of premixed customer selectable color developing materials corresponding to each customer selectable color are provided for each print job. Replacement of the premixed customer selectable color or substitution of another premixed color between different print jobs necessitates operator intervention and print job halts, among other undesirable requirements. Also, since each customer selectable color is typically manufactured at an off-site location, supplies of each customer selectable color printing ink must be separately stored and inventoried for each customer selectable color print job.

In addition, it is known that properties of the printable substrate also affects the color of the print. Many paper substrates are slightly off-white in the direction of blue or green or yellow. Such paper tint can shift the print color away from the customer-selected color, even though the developed ink layer is maintained exactly at its specified value. It is further known that the reflectivity of the substrate also effects the print color. More reflective substrates may result in color with higher gloss, higher brightness and higher measured color saturation then might otherwise be desired.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the invention, a method for adjusting fractional amounts of primary colorants to be combined to substantially match a user selected color and substrate characteristics in a device adapted to color printing on a substrate. The method

comprising the steps of determining a compensated target transmission spectrum, T_{comp} (λ) of a printable ink layer; optimizing an uncompensated target transmission spectrum, $T_{un-comp}$ (λ) of a printable ink layer; and comparing $T_{un-comp}$ (λ) with T_{comp} (λ) plus a predetermined delta and selecting fractional amounts of primary colors to be combined to substantially match the user selected color and the substrate characteristics.

In accordance with another embodiment, a method for determining optical characteristics of a substrate to be printed on and adjusting color components of a desired color to compensate for the optical characteristics. The method comprising the steps of determining optical characteristics of a desired color; determining optical characteristics of the substrate to be printed on; and comparing the optical characteristics of the desired color and the optical characteristics of the substrate to be printed on and adjusting the color components of the desired color to compensate for the optical characteristics of the substrate to be printed on.

In accordance with another embodiment, a color mixing system in an apparatus adapted to printing color documents. The system comprising a source of a plurality of primary colorants; at least one optical characteristic source; at least one user interface; and a controller connectable to the at least one optical characteristic source and the at least one user interface, wherein the controller controls mixing of a plurality of primary colors from the source of primary colorants in response

to the at least one optical characteristic source and the at least one user interface.

In accordance with another embodiment, a program storage device readable by a machine, tangibly embodying a program of instructions executable by the machine to perform method steps for adjusting fractional amounts of primary colors to be combined to substantially match a user selected color and substrate characteristics in a device adapted to color printing on a substrate. The method comprising the steps of determining a compensated target transmission spectrum, $T_{comp}(\lambda)$ of a printable ink layer, further comprising the steps of determining a color reflection spectrum, $R_{tgt}(\lambda)$, determining a substrate reflection spectrum, $R_s(\lambda)$, determining an average front surface substrate reflection, R_{fs}, combining $R_{tgt}(\lambda)$, $R_s(\lambda)$, and R_{fs} to produce the target transmission spectrum, $T_{comp}(\lambda)$; optimizing an uncompensated target transmission spectrum, $T_{un\text{-}comp}(\lambda)$ of a printable ink layer, further comprising the step of optimizing:

EBC 7/21/01

~~$T_{un\text{-}comp}(\lambda) = \exp(\sum_j \alpha_j MC_j(\lambda))$,~~ $T_{un\text{-}comp}(\lambda) = \exp\left(-\sum_j PMA_j \cdot \alpha_j(\lambda)\right)$

where:
exp= 2.71828...

EBC 7/21/01

~~α_j = a mathematical mass associated with each primary color j,~~ PMA_j = the printed mass per unit area associated with the primary color j

~~$MC_j(\lambda)$, = the master curve associated with each primary color j;~~ $\alpha_j(\lambda)$ = the color absorption spectrum associated with the primary color j,

EBC 7/21/01

and comparing $T_{un\text{-}comp}(\lambda)$ with $T_{comp}(\lambda)$ plus a predetermined delta and selecting fractional amounts of primary colorants to be combined to substantially match the user selected color and the substrate characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and other features of the present invention are explained in the following description, taken in connection with the accompanying drawings, wherein:

Fig. 1 is a perspective view of a conventional document processing apparatus adaptable to color printing;

Fig. 2 is a schematic diagram of one embodiment of the invention; and

Fig. 3 is a method flow chart of one embodiment of the invention showing the steps for determining the fractions of colorants to be mixed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figs. 2 and 3 there is shown a schematic and method flow chart of one embodiment of the invention. Although the present invention will be described with reference to the single embodiment shown in the drawings, it should be understood that the present invention can be embodied in many alternate forms of embodiments.

The present invention contemplates a printing system wherein the fraction of color components of the colorant material to be mixed in a supply reservoir can be adjusted to account for paper substrate properties. In

this manner, the color printed on the printable substrate will be in agreement with a predetermined customer selected color. Additionally, there may be more than one combination of fractional amounts of color components and substrate properties that meet the requirements of a customer selected color. By monitoring the mixed color materials, and selecting a different combination if a particular component is below a predetermined threshold, a wide range of customer selectable colors can be produced and maintained over very long print runs. Thus, the invention advantageously permits the user to mix user selected colorants on an as needed basis and to account for paper characteristics when printing a user specified color.

Referring now to Fig. 2, a light source 46B illuminates a paper substrate 50. The reflected light is converted to a signal by an optical sensor 48B and transmitted to control system 52. Control system 52 combines the converted optical data with information from the user interface 56 and ink characteristics from database 54 and determines the fractional amounts of ink from the primary ink supplies 40 to be mixed in reservoir 42 to compensate for the optical characteristics of the paper substrate 50. Alternatively, the optical characteristics of the paper substrate 50 may be stored as a table of the reflection spectrum $R_s(\lambda)$ and the average front surface reflectance R_{fs} in database 54. The mixed ink from reservoir 42 is applied to ink applicator 44 and printed as required on to paper substrate 50. Alternatively, the ink characteristics and the relative proportions of the primary ink color supplies already mixed 42 may be estimated by measuring the transmission spectra of the

light 46C transmitted through or light 46A reflected from a thin layer of the mixed colorant 46D by color sensor 48A. The proportions, e.g., the weight percents or the volume percents, of the constituent colorants of the mixed ink 42 are ascertained by Control System 52 and combined with the paper substrate characteristics from color sensor 48B. The required adjustment to the output color is then made by selectively adding additional amounts of the constituent colorant(s) from the primary ink supplies 40.

Referring also to Fig. 3, the invention determines 10 the reflection spectrum $R_{tgt}(\lambda)$ of the user selected color, determines 12 the reflection spectrum $R_s(\lambda)$ of the target substrate, and determines 14 the average front surface reflectance R_{fs} of the target substrate. The invention calculates 16 the compensated target transmission spectrum of the printable ink layer using known relations between ink transmission, substrate reflectivity and perceived color:

$$T_{comp}(\lambda) = F[R_{fs}, R_s(\lambda), R_{tgt}(\lambda)] \quad (1)$$

Where R_{fs} is the front surface reflectivity of the ink on the paper, R_s is the reflection spectrum of the substrate, and R_{tgt} is the reflection spectrum of the customer selected color. The relationship between these quantities may be determined empirically or from color models. As an example of a specific, approximate relationship, the control system may assume that

$$R(\lambda) = R_{fs} + (1-R_{fs}) * T(\lambda) * R_s(\lambda) * T(\lambda) \quad (1a)$$

and the control system may calculate

$$T_{comp}(\lambda) = SQRT[\ (R_{tgt}(\lambda) - R_{fs}) / ((1-R_{fs})*R_s(\lambda))\ ] \qquad (1b)$$

In one embodiment of the invention the next step estimates 18 a target transmission spectrum of the printable ink layer that is not compensated for the substrate properties. This estimate may come from a stored data base of target colors and the appropriate transmission spectra for inks printed on a standard substrate. Or this estimate may be calculated from empirically or theoretically determined relations between printed color masses per unit area, PMA, color absorption spectra, $\alpha(\lambda)$, and transmission spectra

$$T_{un\text{-}comp}(\lambda) = F[\ PMA_j,\ \alpha_j(\lambda),\ j = 1, N\ ] \qquad (2)$$

where $j = 1, N$ designates the set of individual colorants to be mixed to produce the customer selected color. As an example of a specific, approximate relationship, the control system may assume Beer's law and Lambert's law and determine

$$T_{un\text{-}comp}(\lambda) = \exp(-\Sigma_j\ PMA_j*\alpha_j(\lambda)\ ) \qquad (2a)$$

The PMA_j in equation 2a may come from a stored data base of colorant combinations known to produce different selectable colors, e.g., from the Pantone® system. Equation 2a is only exact under when certain assumptions are satisfied, e.g., that light is not multiply scattered in passing through the ink layer. In other embodiments of the invention, empirical adjustments to equation 2a may

EPC 7/21/00

be made, e.g., to correct for multiple scattering of light in the printed ink layer.

The next step compares 20 the results of equation (1) with the results of equation (2) to determine if $T_{comp}(\lambda)$ is within a predetermined range of $T_{un\text{-}comp}(\lambda)$.

If the comparison falls outside the predetermined range the next step determines 22 if the variables used in determining $T_{un\text{-}comp}(\lambda)$ have been optimized. If the variables have not been optimized a conventional multivariate optimization (e.g., least squares, Simplex, e.t.c.) may be used to optimize 26 the PMA_j or other parameters until $T_{un\text{-}comp}(\lambda)$ is sufficiently close to $T_{comp}(\lambda)$. Otherwise the user may be notified 28 that the selected color is incompatible with the target substrate color.

If the comparison of $T_{un\text{-}comp}(\lambda)$ is sufficiently close to $T_{comp}(\lambda)$ then the fraction and color F_j of each primary colorant j to be mixed is determined 24 according to the equation

$$F_j = PMA_j / PMA_{tot} \qquad (3)$$

where

$$PMA_{tot} = \sum_j PMA_j \qquad (4).$$

Step 30 determines if the fractional amount F_j is below a predetermined reservoir level for that j_{th} color and selecting an alternative combination of α_j and recalculates 36 equation (1) and re-compares 20 the results of equation (1) with the results of equation (2)

to determine if T_{comp} (λ) is within a predetermined delta of $T_{un\text{-}comp}$ (λ).

Steps 29 and 32 are used to control the number of times alternative solutions to T_{comp} (λ) are determined. If loop control maximum has been set 29 and so determined 32 then the user is notified 34.

It should be understood that the foregoing description is only illustrative of the invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. For example, present invention relates document processing machines adapted to color printing such as, for example, ink jet printers, and is not restricted to xerographic machines. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

CLAIMS

What is claimed is:

1. A method for adjusting fractional amounts of primary colors to be combined to substantially match a user selected color and substrate characteristics in a device adapted to color printing on a substrate, the method comprising the steps of:

determining a compensated target transmission spectrum, T_{comp} (λ) of a printable ink layer;

optimizing an uncompensated target transmission spectrum, $T_{un\text{-}comp}$ (λ) of a printable ink layer; and

comparing $T_{un\text{-}comp}$ (λ) with T_{comp} (λ) plus a predetermined delta and selecting fractional amounts of primary colors to be combined to substantially match the user selected color and the substrate characteristics.

2. A method as in claim 1 wherein the step of determining the compensated target transmission spectrum, T_{comp} (λ), further comprises the steps of:

determining a color reflection spectrum , $R_{tgt}(\lambda)$;

determining a substrate reflection spectrum , $R_s(\lambda)$;

determining an average front surface substrate reflection, R_s; and

combining $R_{tgt}(\lambda)$, $R_s(\lambda)$, and R_{fs} to produce the target transmission spectrum, $T_{comp}(\lambda)$.

3. A method as in claim 2 wherein the step of combining $R_{tgt}(\lambda)$, $R_s(\lambda)$, and R_{fs} to produce a target transmission spectrum, $T_{comp}(\lambda)$ further comprises the steps of:

determining $T_{comp}(\lambda)$, according to the equation:

$$T_{comp}(\lambda) = SQRT\ ((R_{tgt}(\lambda) - R_{fs})/((1-R_{fs})* R_s(\lambda))),$$

where SQRT = square root of.

4. A method as in claim 1 wherein the step of optimizing the uncompensated target transmission spectrum, $T_{un-comp}(\lambda)$ further comprises the step of optimizing:

$$T_{un-comp}(\lambda) = F(PMA_j, \alpha_j(\lambda), j=1,n)$$

where

PMA_j = the printed mass per unit area associated with the primary colorant j; and

α_j = the absorption coefficient of the j-th colorant at wavelength λ.

5. A method as in claim 4 wherein the step of optimizing $T_{un-comp}(\lambda)$ further comprises the steps of:

measuring reflection spectra of known PMA_j for j=1,n, where n is the number of primary colorants;

determining $\alpha_j(\lambda)$ and empirical adjustments to the approximate equation, $T_{un-comp}(\lambda) = \exp(-\Sigma_j\ PMA_j * \alpha_j(\lambda))$,

where exp = 2.71828…, such that the accuracy of the empirical equation, $R(\lambda) = R_{fs} + (1-R_{fs})*T(\lambda)*R_s(\lambda)*T(\lambda)$, is improved; and

selecting at least one combination of PMA_j such that the calculated $T_{un\text{-}comp}(\lambda)$ plus or minus the predetermined delta substantially equals $T_{comp}(\lambda)$.

EBC 7/21/00 →

6. A method as in claim 5 wherein the step of selecting at least one combination of ~~α_j~~ and ~~$MC_j(\lambda)$~~ PMA_j $\alpha_j(\lambda)$ further comprises the steps of:

determining a printed mass per unit area (PMA) per primary color, PMA_j;

determining the total PMA_{tot} according to $\sum_j PMA_j$, for j= 1 to n, where n= number of primary colors;

calculating the fractional amount of primary color, Fj, according to $Fj = PMA_j/PMA_{tot}$; and

determining if the fractional amount F_j is below a predetermined reservoir level for that j-th color and selecting an alternate combination of PMA_j such that the calculated $T_{un\text{-}comp}(\lambda)$ plus or minus the predetermined delta substantially equals $T_{comp}(\lambda)$..

7. A method as in claim 1 wherein the step of comparing $T_{un\text{-}comp}(\lambda)$ with $T_{comp}(\lambda)$ plus a predetermined delta and selecting fractional amounts of primary colors to be combined further comprises the step of selecting fractional amounts of primary colors from a composition table.

8. A method as in claim 2 wherein the step of determining the color reflection spectrum coefficient, $R_{tgt}(\lambda)$ further comprises the step of selecting R_{tgt} from a database.

9. A method as in claim 2 wherein the step of determining the substrate reflection spectrum coefficient, $R_s(\lambda)$ further comprises the step of selecting $R_s(\lambda)$ from a database.

10. A method as in claim 2 wherein the step of determining the substrate reflection spectrum coefficient, $R_s(\lambda)$ further comprises the step of selecting $R_s(\lambda)$ from a database.

11. A method as in claim 2 wherein the step of determining the substrate reflection spectrum coefficient, $R_s(\lambda)$ further comprises the step of measuring $R_s(\lambda)$.

12. A method as in claim 2 wherein the step of determining the substrate reflection spectrum coefficient, $R_s(\lambda)$ further comprises the step of reading $R_s(\lambda)$ from a packaging label.

13. A method as in claim 2 wherein the step of determining the substrate reflection spectrum coefficient, R_{fs} further comprises the step of selecting R_{fs} from a database.

14. A method as in claim 2 wherein the step of determining the substrate reflection spectrum coefficient, R_{fs} further comprises the step of measuring R_{fs}.

15. A method as in claim 2 wherein the step of determining the substrate reflection spectrum coefficient, R_{fs} further comprises the step of reading R_{fs} from a packaging label.

16. A method for determining optical characteristics of a substrate to be printed on and adjusting color components of a desired color to compensate for said optical characteristics, the method comprising the steps of:

determining optical characteristics of a desired color;

determining optical characteristics of the substrate to be printed on; and

comparing the optical characteristics of the desired color and the optical characteristics of the substrate to be printed on and adjusting the color components of the desired color to compensate for said optical characteristics of the substrate to be printed on.

17. A method as in claim 16 wherein the step of determining the optical characteristics for the desired color further comprises the step of determining the reflection spectrum of the desired color.

18. A method as in claim 16 wherein the step of determining optical characteristics of the substrate to be printed on further comprises the steps of:

determining the reflection spectrum of the substrate to be printed on; and

determining the average front surface reflection of the substrate to be printed on.

19. A color mixing system in an apparatus adapted to printing color documents, the system comprising:

a source of a plurality of primary colorants;

at least one optical characteristic source;

at least one user interface; and

a controller connectable to the at least one optical characteristic source and the at least one user interface, wherein the controller controls mixing of a plurality of primary colors from the source of primary colorants in response to the at least one optical characteristic source and the at least one user interface.

20. A color mixing system as in claim 19 wherein the at least one optical characteristic source further comprises a substrate reflection spectrum $R_s(\lambda)$ sensing device, alternatively the at least one optical characteristic source comprises a stored table of $R_s(\lambda)$ values.

21. A color mixing system as in claim 19 wherein the at least one optical characteristic source is a substrate average front surface reflection R_{fs} sensing device, or a stored table of R_{fs} values.

22. A color mixing system as in claim 19 wherein the at least one optical characteristic source further comprises a reflection spectrum database having at least one reflection spectrum $R_{tgt}(\lambda)$ of a user selected color.

23. A program storage device readable by a machine, tangibly embodying a program of instructions executable by the machine to perform method steps for adjusting fractional amounts of primary colors to be combined to substantially match a user selected color and substrate characteristics in a device adapted to color printing on a substrate, the method comprising the steps of:

determining a compensated target transmission spectrum, $T_{comp}(\lambda)$ of a printable ink layer, further comprises the steps of determining a color reflection spectrum , $R_{tgt}(\lambda)$, determining a substrate reflection spectrum , $R_s(\lambda)$, determining an average front surface substrate reflection, R_{fs}, combining $R_{tgt}(\lambda)$, $R_s(\lambda)$, and R_{fs} to produce the target transmission spectrum, $T_{comp}(\lambda)$;

optimizing an uncompensated target transmission spectrum, $T_{un\text{-}comp}(\lambda)$ of a printable ink layer, further comprises the step of optimizing:

~~$T_{un\text{-}comp}(\lambda) = \exp(-\Sigma_j \alpha_j MC_j(\lambda))$~~, where exp= 2.71828...

EBC 7/21/00 → $T_{un\text{-}comp}(\lambda) = \exp\left(-\sum_j PMA_j \cdot \alpha_j(\lambda)\right)$

~~α_j = a mathematical mass associated with each primary color j,~~

EBC 7/21/00 → PMA_j = the printed mass per unit area associated with the primary color j,

~~$MC_j(\lambda)$, = the master curve associated with each primary color j; and~~

EBC 7/21/00 → $\alpha_j(\lambda)$ = the color absorption spectrum associated with primary color j, and

optimizing an uncompensated target transmission spectrum, $T_{un\text{-}comp}(\lambda)$ of a printable ink layer, further comprises the steps of:

adjusting PMA_j to minimize differences between $T_{un\text{-}comp}(\lambda) = F[\ PMA_j, \alpha_j(\lambda), j = 1,N\ ]$ and $T_{comp}(\lambda)$, where PMA_j is the printed mass per unit area of the j-th primary color, $\alpha_j(\lambda)$ is the absorption coefficient of the j-th primary color at wavelength λ; and

comparing $T_{un\text{-}comp}(\lambda)$ with $T_{comp}(\lambda)$ plus or minus a predetermined delta and selecting fractional amounts of primary colors to be combined to substantially match the user selected color and the substrate characteristics.

ABSTRACT

A method for adjusting fractional amounts of primary colors to be combined to substantially match a user selected color and substrate characteristics in a device adapted to color printing on a substrate. The method corrects for both the color and the reflectivity of the substrate on which the user selected color is to be printed. The method adjusts the target mixed ink transmission spectrum to compensate for the substrate characteristics. The method also identifies cases in which the target mixed ink transmission spectrum may not be compensated due to the paper's color. The method may be used to control mixing of inks in a custom color module of a marking engine; or mixing of dry toner primaries in a dry xerographic engine; or mixing of printing inks in a stand-alone ink mixing station.

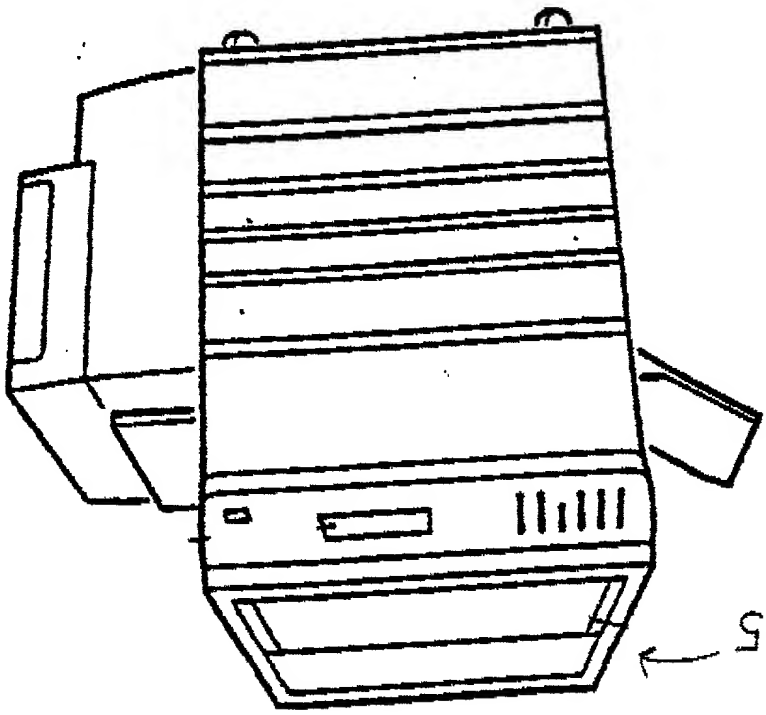


Fig. 1
Prior Art

Fig. 2

Schematic Ink Mixing System

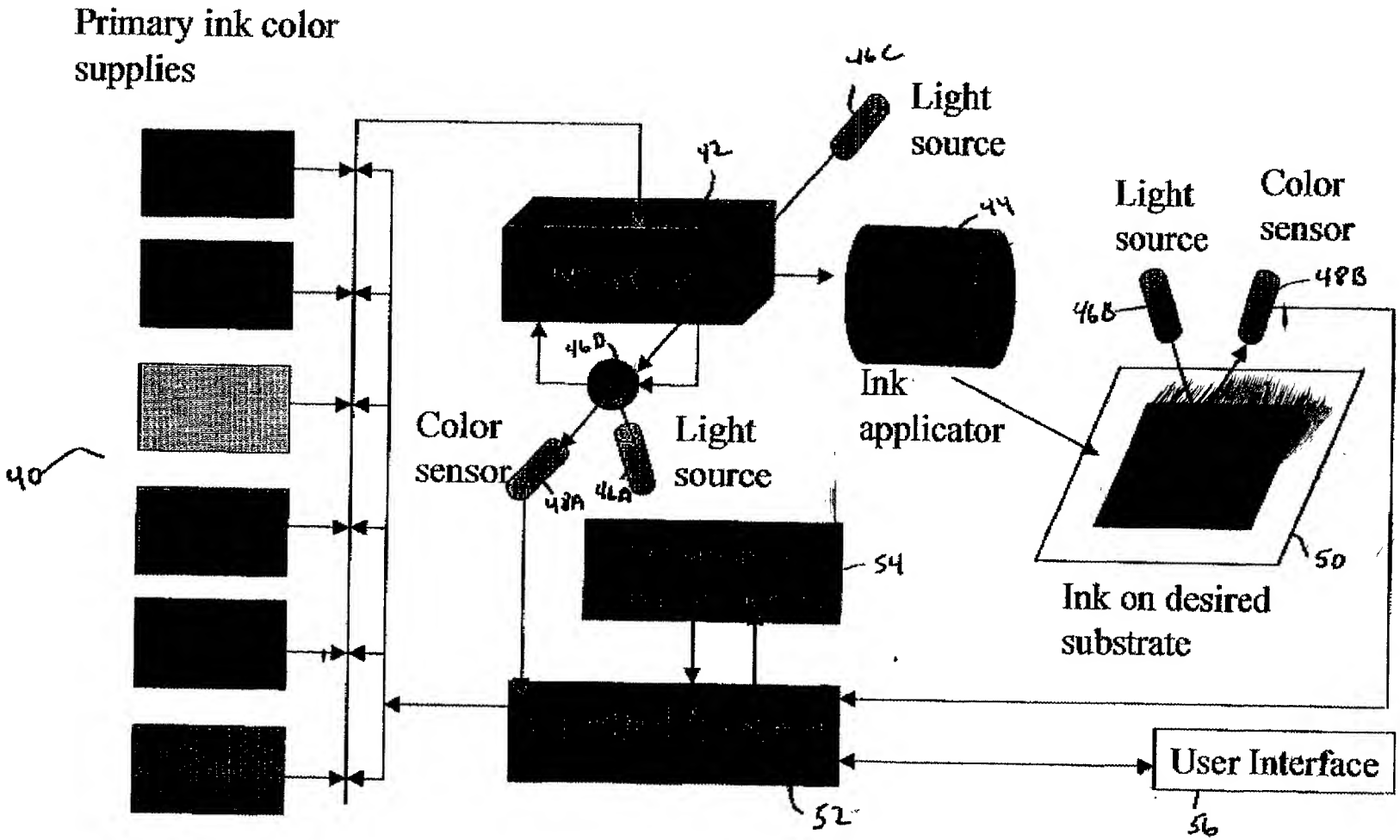
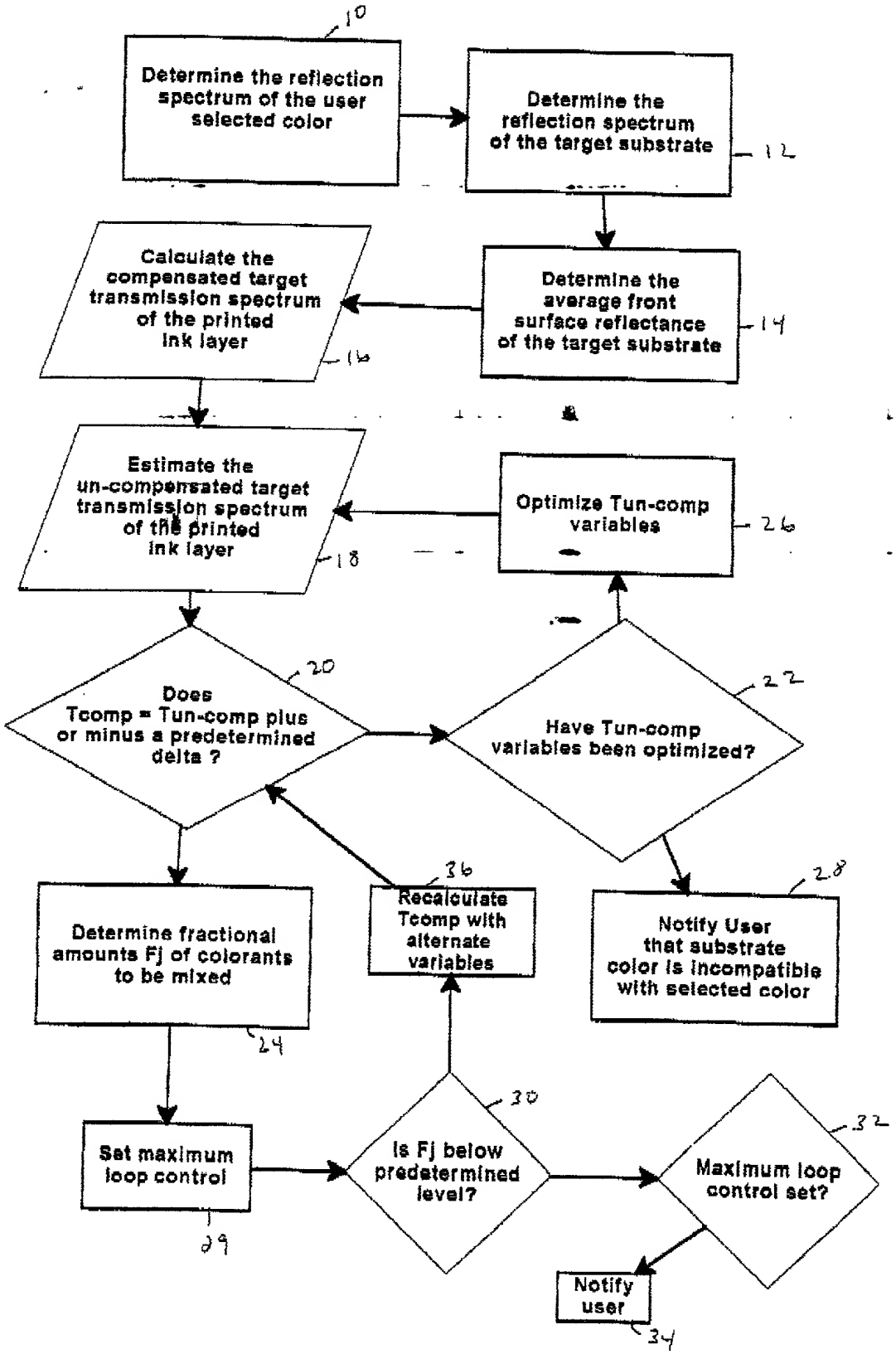


Fig. 3



PATENT APPLICATION

Attorney Docket No. D/99644/690-009315-US (PAR)

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **A METHOD AND SYSTEM FOR ADJUSTING COLOR MIXING DUE TO SUBSTRATE CHARACTERISTICS**

the specification and claims of which
☒ are attached hereto OR ☐ was filed on _____ as U.S. Application No. _____

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code, §119 of any foreign or U.S. Provisional application(s) for patent listed below, and have also identified below any foreign application(s) or Provisional application(s) for patent having a filing date before that of the application on which priority is claimed:

Prior Foreign or U.S. Provisional Application(s)

(Number)	(Country)	(Day/Month/Year Filed)
[illegible]	USA	July 21, 2000

N.A.
EBC 7/21/2000

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following registered practitioners to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

John E. Beck	**Reg. No. 22,833;**	**Henry Fleischer**	**Reg. No. 25,682;**
Ronald F. Chapuran	**Reg. No. 26,402;**	**Eugene O. Palazzo**	**Reg. No. 20,881;**
Mark Costello	**Reg. No. 31,342;**	**Denis A. Robitaille**	**Reg. No. 34,098;**
Richard B. Domingo	**Reg. No. 36,784;**	**Clarence A. Green**	**Reg. No. 24,622**
		Mark F. Harrington	**Reg. No. 31,686**
			Reg. No.

ADDRESS ALL CORRESPONDENCE TO:
Kevin P. Correll
Perman & Green, LLP
425 Post Road
Fairfield, CT 06430

DIRECT TELEPHONE CALLS TO:
(name and telephone number)
Kevin P. Correll
(203) 259-1800

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Attorney Docket No. D/99844/690-009315-US (PAR)

DECLARATION AND POWER OF ATTORNEY, continued

Name of sole or first inventor: Edward B. Caruthers

Inventor's Signature: _____ Date: July 21, 2000

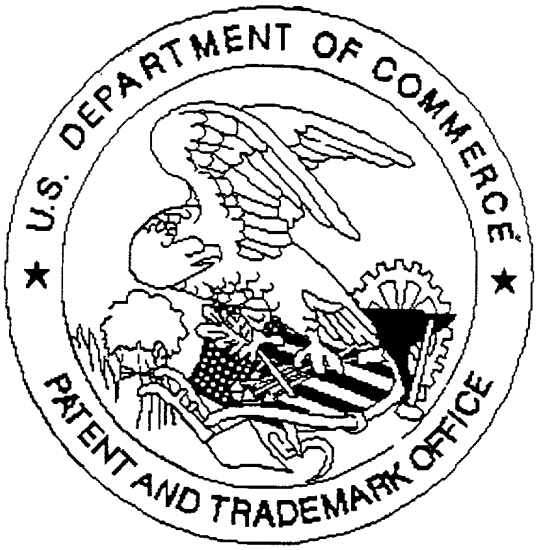
Residence: 7 Cranswick Lane, Rochester, NY 14618

Citizenship: USA

Post Office Address:
(Same as above)

United States Patent & Trademark Office

Office of Initial Patent Examination -- Scanning Division



Application deficiencies were found during scanning:

☐ Page(s)_____ of _____ were not present for scanning.
(Document title)

☐ Page(s)_____ of _____ were not present for scanning.
(Document title)

☑ Scanned copy is best available.

Specification